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## LIFE HISTORY OF *VANDUZZEA ARQUATA* SAY (MEMBRACIDÆ).<sup>1</sup>

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Although *Vanduzzea arquata* Say is one of the most widely distributed of the species of Membracidæ in the United States, its life history has not hitherto been described. The species is very abundant in the vicinity of Ithaca, N. Y., on locust (*Robinia pseudacacia* L.) and the following study has been made during the summers of the past five years, the data being compiled largely from field notes made during that time. For three years almost daily notes were made of the life history of this Membracid including date, locality, host, weather and temperature records, and the insects were observed under natural conditions. Specimens were reared in the insectary merely to ascertain the lengths of the various instars, and these laboratory records have been used only as a check upon the field notes. *Vanduzzea arquata* is by far the most common Membracid in the Cayuga Lake basin and no difficulty has been experienced in securing both adults and nymphs throughout the season.

I am indebted to Professor O. A. Johannsen of the Entomological Department of Cornell University for his very helpful suggestions and criticisms in the course of this study, and to Professor W. M. Wheeler of the Bussey Institution, Harvard University, for the determination of the ants which are attendant on this species of Membracid.

### HISTORICAL.

This insect was described by Say as *Membracis arquata* in 1831 (Journ. Acad. Nat. Sci. VI: 302. 12). Fitch recorded it as

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<sup>1</sup>Contribution from the Entomological Laboratory of Cornell University.

a *Carynota* in 1851 (Cat. Hom. N. Y., 48. 651) and Walker in the same year (List Hom. B. M., 144. 2) also placed it in this genus. Van Duzee mentioned it as *Ophiderma arquata* in 1890 (PSYCHE V: 389) in which genus it remained until Goding made it the type of his new genus *Vanduzea* in 1894 (Catalogue of Described Membracidae of North America, 440. 136). The species has been often mentioned in literature and Matusch has published an excellent figure of the last instar in his paper on the last nymphal stages of Membracidae in 1912 (Bull. Amer. Mus. Nat. Hist. XXXI: Pl. 32, Fig. 16). Van Duzee gives its principal range as from Ohio southward (Bull. Buffalo Soc. Nat. Sci. IX: 103) but it has also been recorded from most parts of the United States east of the Rocky Mountains.

#### GENERAL DESCRIPTION.

*Vanduzea arquata* is one of the smaller of the species of Membracidae represented in the local fauna. The sexes are quite distinct in size and color, the females being light chocolate-brown with yellowish white fascia and nearly six millimeters long while the males are very dark brown with less extended fascia and much smaller than the females. The dorsum in the males, also, is inclined to be depressed behind the middle, while that of the females is nearly straight in this region. The species may be at once recognized by the straight, transverse base of the terminal cell of the fore-wing, the transversely rounded dorsum, the pubescent pronotum with the characteristic markings (Figs. 9 and 10) and the punctured costal area of the fore-wing.

#### HABITS.

Two species of Membracidae, *Thelia bimaculata* Fab., and *Vanduzea arquata* Say. are commonly found upon the locust in central New York, and of these the latter is more abundant, although less conspicuous, than the former. Locally they may be found in surprising numbers throughout the entire summer, being so numerous, in fact, that it is not unusual to take several hundred individuals from one host plant in a single hour's collecting. The adults and nymphs are found crowded in the notches of the twigs, usually in the irregular crevices left by the old bud-scales of the preceding year, and may be easily located by the

swarms of attending ants which are always to be noticed where the membracids are congregated. The adults seem to be decidedly gregarious and are seldom found alone. From twenty to thirty may be seen closely arranged around the base of a twig, their bodies touching, their heads pointing towards the base of the branch, and often the nymphs concealed in the crevices of the bark below them. Here they rest by the hour, motionless, without change of position, and apparently not even feeding. Unlike most of the local forms of the family, they prefer the upper, rather than the lower sides of the branches, and the adults are very seldom found on the leaves and never on the trunk. They enjoy the sun and are most numerous on the south sides of the trees; they are rarely found in shady places, as the open groves, roadsides, and scattered trees furnish the most favored habitats. Both young and old trees harbor them, but they always choose the lower branches, well out towards the ends. Whether this characteristic location is chosen to favor the attendance of the ants would be a matter of conjecture; certainly they seem in no way averse to this symbiosis.

This Membracid is comparatively active, leaving the branch with a quick "snap" when disturbed and disappearing with a flight too rapid to be followed by the eye. If care is taken, however, they may be secured in the fingers, and after a little practice this proves to be the most satisfactory method of collecting, since they fly well and will not drop to the ground when the limb is beaten, and the thorny host does not lend itself to the use of a net. As in *Thelia bimaculata*, the migration of this species is slow, one tree often being loaded with individuals while another in close proximity is barren. If disturbed, the insects usually return to the same tree from which they were frightened.

Adults first appear in this locality about the first week in June. The earliest record is May 29, 1912, when three females and two males were taken. From this date they are common until late in October, depending on the weather conditions. They have always been found after the first heavy frost<sup>1</sup> and are sometimes persisting and surprisingly active after the first few snows. In

<sup>1</sup> On September 28, 1913, after a very heavy frost in the Cayuga Lake region, thousands of these insects were found on the hills east of the lake. The individuals were sluggish, but several days later, after some warmer weather, seemed as active as in midsummer.

the latter part of the season the males are more numerous than the females—counts made in late September 1911 showed an average of five to one—and this condition has been regularly observed each year. It is of interest to note that the opposite is true of *Thelia bimaculata*, the other species inhabiting the locust, in which species the males become scarcer in August and have practically disappeared by the first of October, although the females persist as do the males of *Vanduzeeia arquata*. There is no evidence to show that adults survive during the winter. Careful examination has failed to show any trace of their hibernation and no adults have been observed in the spring previous to the development of the nymphs.

Nymphs appear locally about the first of May, the earliest field record of their presence being April 26, 1914. They are usually found flattened in the crotch of a twig or axil of a leaf, generally just above the egg-mass from which they hatched. The most usual position shows the head pointing toward the angle in the stem and the body tightly compressed into a crevice in the bark. Their protective resemblance while in this position is excellent and were it not for the attendant ants, the presence of the early stages of the nymphs would escape any but the most careful search. Like most Membracid nymphs which give off an anal liquid, this liquid is excreted when the nymph is picked up or disturbed. The immature forms are very sluggish and merely hold fast to the irregularities of the bark when an attempt is made to remove them. They seldom move more than a few inches from the egg-slit until the last instar, at which time they crawl out to the under-side of a leaflet for the last molt.

Nymphs have been collected in the first and second instars late in October, and it is probable that many of the last brood fail to reach maturity in years in which there is early frost or premature cold weather.

#### MATING AND OVIPOSITION.

Mating begins in the field during the middle of June. The earliest recorded date is June 12, 1911. The pair is usually found in the mass of individuals in the angles of the branches. They seem quite restless at this time and are easily disturbed. When molested they fall to the ground, not, however, becoming detached

from each other. Copulation has been timed for ten minutes, but may average longer. Mating has not been observed generally throughout the summer, but after the period in June the process seems to be discontinued, to become very noticeable again about the middle of August.

There appear to be three rather distinct seasons for egg-laying, one about the middle of June, one the last of July, and one in September; during the summer the eggs are laid at the base of the bud scales of the preceding year, in the fall the eggs are laid in the buds. These periods, however, are more or less irregular, and the nymphs do not all mature at equal rate, so that immature forms of all stages may be found during most of the summer. The eggs laid during the early summer failed to hatch in the laboratory, probably on account of the unnatural sap conditions to which the twig was necessarily subjected, so that it could not be definitely ascertained in the course of this study just what the exact time was which was required for hatching. Field notes, however, record eggs laid on July 15 and the first instars observed on July 29, so that the time is approximately fourteen days. The eggs laid in the fall winter over, and when twigs containing these eggs are brought into the laboratory in the spring, the nymphs emerge shortly after the opening of the bud.

In oviposition the female makes a small, deep puncture and apparently does not remove the ovipositor during the process, although a decided movement of the abdomen may be observed. From three to six eggs are laid in one mass, in a finger-like cluster (Fig. 2), the bases of the eggs being about .3 mm. apart and the tips pressed closely together. The average number of eggs in such a cluster is four. The slit is very small—about 1.5 mm. long—and soon closes after the ovipositor is withdrawn, leaving no external evidence of the process. The eggs are about 1.4 mm. long, white, and club-shaped (Fig. 1), quite large for the size of the insect. The inner surface of the outer bud scales of the locust is covered with a deep, felt-like pile of soft hair which covers and protects the eggs (Fig. 3.) The eggs are laid deep at the base of the scale and the tips do not project out of the host, as in the case of the eggs of some of the other members of this family.<sup>1</sup> One female has been observed to make two such slits,

<sup>1</sup> Cf. Hodgkiss, H. E. The Apple and Pear Membracids. Agr. Exp. Sta. Tech. Bull. 17. Geneva 1910. Pl. 3, Fig. 1.

and sometimes three females have been seen ovipositing at the base of one stem. The large number of individuals of this species which appears every year is probably not due to the large number of eggs laid by one female, but to the large number of egg-masses from different females laid in one host. It is not known how many eggs may be laid by one individual, since it has not been found practicable to keep large pieces of the host plant in the laboratory for any considerable length of time.

#### EMERGENCE AND DEVELOPMENT OF NYMPHS.

Although the first nymphs do not begin to appear in this locality until early in May, they may be forced in the laboratory earlier than this. The eggs break open widely at the tips but the nymphs sometimes delay emergence for several days after the eggs have begun to open.

Five instars are passed in the process of development. The first is characterized by the long, fine, hair-like bristles which extend in three rows down both sides of both the thorax and the abdomen, and by the white band down the median dorsal line of the body (Fig. 4). In the second instar (Fig. 5) the lateral bristles have disappeared and the entire body is hairy while the dorsal bristles are simple and long on both thorax and abdomen. The third instar (Fig. 6) shows no dorsal bristles on the thorax and the abdominal bristles are heavy and branched; the pronotum has begun to extend itself posteriorly and the lateral margins of the meso- and metathorax are beginning to form the rudimentary wing-pads. In the fourth instar (Fig. 7) the pronotum covers the dorsal part of the mesonotum and the wing-pads are well developed, reaching to the second segment of the abdomen. The fifth and last instar (Fig. 8) presents a greatly developed pronotum which now covers both the mesonotum and the metanotum, and the wing-pads are fully formed, reaching to the third abdominal segment. Thus each instar may be recognized by rather clearly defined characters of the thorax and abdomen.

The time occupied in this process is subject to considerable variation and all of the nymphs from one egg-mass do not reach maturity at the same time, there being sometimes a difference of as much as two weeks between the maturing of the earliest and latest individuals. An average laboratory record shows the

following data for one individual: first instar, 5 days; second, 3 days; third, 3 days; fourth, 4 days; fifth, 6 days; total, 21 days. Much difficulty was experienced in recording the second and third molts which were very erratic and often, for some reason, the second molt could not be discovered at all, the nymphs appearing to pass over this molt entirely. Although 21 days is thus given as the average, the period from egg to adult has been known to last for 33 days, and in the most rapid growth observed, occupied 18 days. A twig in the field, harboring nymphs of the first instar, was enclosed in netting on July 30, 1913, and the first adults appeared from this brood on August 16, making a total of 17 days. Presuming that the nymphs were two or three days old when first found, which was very likely the case, this field record conforms very well with the average. The averages of a considerable number of observations gives the following summary as perhaps the normal:

	Days
First instar .....	5- 8
Second instar.....	3- 5
Third instar.....	3- 5
Fourth instar.....	3- 6
Fifth instar.....	5-10
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Total.....	19-34

#### ECDYSIS.

The first splitting of the integument appears down the median line of the thorax, and not on the dorsal part of the head as in most cases which have been observed in the Membracidae. The skin over the head opens next and then that on the dorsal line of the abdomen, the latter splitting for practically its whole length. In the last molt the insect usually creeps out to the under side of a leaflet and fastens itself securely by the first two pairs of legs. The last pair of legs is left free and used to a slight extent in the process. The dorsal part of the thorax emerges first, quickly followed by the head; the legs are then withdrawn rather slowly and the abdomen pulled out more or less sidewise as the insect seeks a new foothold beside the old skin. The time consumed in this process is from five to twelve minutes. The exuviae are usually perfect and may be found hanging to the underside of the

leaflet for many days after ecdysis. These old skins are particularly abundant locally during the middle of August.

The newly emerged adults are soft-bodied and yellowish in appearance and the normal color is not entirely evident nor the pronotum completely hardened for more than twelve hours after emergence. The insects fly in ten minutes after the last molt.

#### BROODS.

On account of the overlapping of the stages of nymphal development and the consequent prolongation of mating periods after maturity, no definite number of days can be assigned to the period from oviposition to the adult stage. The failure to rear individuals from the eggs laid during the summer, also, has made it impossible to determine the exact period of incubation for these eggs, and the estimation of the number of broods can be based only on observations in the field. Since, however, the first adults which have hatched from the winter eggs do not appear until about the first of June and the first nymphs from this generation are to be found about the first of July, it would appear that the time required for mating, oviposition, incubation and hatching is approximately one month. As these nymphs require about twenty days for development, the total period between generations of adults would be nearly six weeks. Under favorable seasonable conditions, then, it may be estimated that there are three broods during the summer and one from the winter eggs, making four broods per year. Thus the greatest number of adults would be expected in early June, the middle of July, the last of August and the middle of October, and the greatest number of nymphs in early May, the middle of June, the last of July and the middle of September. Field observations bear out this theory very well, although, as has been stated, the variations in periods of development make it possible to find nymphs of practically all stages throughout the summer.

#### FEEDING.

The beak of the Membracid is well fitted for piercing, being strong and heavy, and fitted with bristle-like mandibular and maxillary setæ. Both nymphs and adults have little difficulty in forcing the beak almost as far as the clypeus into the young stems



and the petioles of the leaves, the parts of the plants on which they most commonly feed. Feeding may be observed at almost any hour during the day but the most favored time appears to be the middle of the afternoon. The fact that their bird enemies are not usually present during the heat of the day might be advanced as a reason for the activity of the insects at this time. The Membracids do not, however, display any great energy in their feeding movements. They remain in one spot for a long time, seeming to find an inexhaustible supply of sap at each insertion of the mouthparts, and they show little disposition to seek new feeding places. So deeply and firmly is the beak buried in the tissue of the host, and so absorbed do the insects appear to be while obtaining food, that often, in collecting, the mouthparts are broken off and left in the stem when the specimen is captured.

#### ECOLOGY.

Environmental conditions undoubtedly play an important part in the life history of this insect, and it seems very likely that when sufficient experimental data is available it will be found that many of the seeming irregularities in the periods of development which have been noted, may be explained by the variation in temperature and moisture to which the eggs and nymphs are subjected. While no definite facts have been secured experimentally in the course of this study on the relation of this insect to its environment, several suggestive features have been noted which bear on this phase of the subject.

The summer of 1913 was the occasion of the worst drought which has been experienced in this locality for many years. Vegetation suffered greatly and the Weather Bureau reported that all recent records were broken for lack of rainfall at the Ithaca station. It was during this summer that the field records showed the most variation in the appearance of the broods of *Vanduzeeia arquata*. The early spring of 1914, on the other hand, was marked by unusual precipitation and during this spring the eggs hatched earlier than in former years. In the same manner it has been observed that the nymphs developed more rapidly when the days were warm than they did during weeks of cold and unseasonable weather. As might be expected, also, early springs and

late winters have occasioned correspondingly early appearance and late persistence of the forms in the field.

Such conditions seem undoubtedly to affect the eggs and the nymphs, and may very logically be presumed to have an influence also on the mating, oviposition and general activities of the adults.

#### HOSTS.

*Robinia pseudacacia* L. seems to be by far the most favored if not the only host in this locality. Specimens of *Vanduzea arquata* have been collected on willow, oak, elm and wild cherry in localities where there were no locusts in the immediate vicinity but as the Membracid under consideration flies well, its appearance on these trees may have been accidental. No evidences of eggs or nymphs have ever been found except on the locust, nor have specimens ever been collected in the grass or weeds or by sweeping, so that it seems evident that the entire life cycle of the insect is usually spent on this one host. Van Duzee gives the locust as the dominant host for Ohio and southward (Studies in North American Membracidae, 103. 1).

It may be of interest to note that, although *Robinia viscosa* Vent. and *Gleditsia triacanthus* L. are well represented in the local flora, they are never found as habitats for these Membracids.

#### ENEMIES.

This species of Membracidae seems to have few natural enemies. The eggs are not infrequently parasitized but the writer has not been able to rear the parasites and they have not been determined. The parasitism does not seem to extend to the nymphs or the adults and, although a large number of both have been dissected with a view to ascertaining this fact, no parasitic larvæ have been found. This is rather remarkable in view of the fact that the local forms of the genera *Telamona* and *Thelia* are commonly parasitized.

Birds feed on the nymphs but not to any great extent. A chipping sparrow has been watched industriously searching for the immature forms but neglecting the adults. The latter are probably sufficiently protected from bird enemies by the hard pronotum and sharp posterior process. A number of instances of

spiders capturing the Membracids have been recorded and the adults are occasionally found in spider webs, although in most cases the spiders have been seen to capture the Membracid on the twig and spin the web around the body until the insect was enclosed in a cocoon-like mass, after which it was carried away. In these instances the Membracids did not appear to have been bitten by the spider, at least not to the extent of paralysis, for the legs could be seen moving and the body struggling after the encasement in the web. Here, again, the hard pronotum probably proved a method of protection. One instance has been noted of an Asilid (*Erax bastardii* Macq.) carrying off an adult, and one instance, also, of a Mantis feeding on a nymph.

#### ATTENDANCE BY ANTS.

Both nymphs and adults are commonly attended by ants and this appears to always be the case where the Membracids are present in large numbers. The ants stroke their charges with their antennæ whereupon the Membracids give off from the anal tube a liquid that issues in bubbles in a considerable quantity. The anal tube of *Vanduzea arquata* is capable of great evagination, especially in the nymphs in which it is long, black and cylindrical and usually tipped with a fringe of fine hairs. The so-called "honey-dew" is eagerly taken from the end of this tube by the ants. In this species the adults as well as the nymphs are sought, and the ants seem to be as attentive to one as to the other, but the adults have not been observed to excrete the liquid to the same extent as the nymphs. The mutual relationship of the two insects offers a most interesting field for study and has been observed in other Membracidæ by a number of authors at various times. The more important references to the subject are by Baer, Belt, Buckton, Green, Lamborn, Miss Branch and Mrs. Rice.<sup>1</sup>

<sup>1</sup>Baer, G. A. Note sur une Membracide myrmécophile. Ann. Soc. Ent. France, 1903. LXXII: Bull. 306.

Belt, T. Honey exuding Membracidæ attended by ants. Naturalist in Nicaragua. 1874.

Buckton, G. B. Ants and Membracidæ. Monograph of the Membracidæ. 1903. 262 p.

Green, E. E. Note on the attractive properties of certain larval Hemiptera. Ent. Month. Mag. Aug. 1900. XXXVII: 185 p.

Lamborn, W. A. Ants and Membracidæ. Trans. London Ent. Soc. 1913 494-498 p.

Poulton, E. B. Suggestions as to the meaning of the shapes and colours of the Membracidæ. In Buckton's Monograph. 273-285 p.

Branch, Hazel E. Morphology and Biology of the Membracidæ of Kansas. Kansas University Bull. 1913. VIII: No. 3. 84 p.

Rice, Mrs. M. E. *Entylia sinuata*. Insect Life. 1893. V: No. 4. 243-245 p.

The species of ants which have been found locally attending *Vanduzea arquata* have been determined by Professor Wheeler as follows: *Formica obscuriventris* Mayr., *Formica exsectoides* Forel, *Camponotus pennsylvanicus* DeGeer, *Crematogaster lineolata* Say, *Prenolepis imparis* Say.

#### ECONOMIC IMPORTANCE.

Although the immense number of insects, with their attendant feeding and oviposition, would naturally be supposed to affect the host, very little damage, as a matter of fact, seems to result from their existence on the locust. The amount of sap consumed would of course be practically negligible and the buds seem in no way retarded in their development by the presence of the eggs. The egg-slits are very small and heal very quickly, leaving no wound, and no trace has been found of fungus or of other insects in these incisions. A careful comparison of trees in the field fails to show that those harboring this species of Membracidæ are in any way less sturdy than those on which the insects are not found. These facts have led to the conclusion that the economic importance of the insect is hardly to be considered.

#### TECHNICAL DESCRIPTIONS.

##### *Egg.*

Measurements: Length 1.4 mm.; maximum width .3 mm.

Smooth, without sculpturing; white; club-shaped; neck gradually acute, very slightly grooved; micropyle oval, opening tangential to longitudinal axis; base smooth, rounded; chorion white translucent; cap small, subcylindrical.

##### *First Instar.*

Measurements: Length 1.2 mm.; maximum width .25 mm.

Very light grayish-brown with top of head and line down median dorsum white; six longitudinal rows of long, white bristly hairs, two rows down dorsum and two rows on each side; abdomen upraised; entire body noticeably long in proportion to its width.

Head broad, gray-brown in front, white and produced above, covered with white bristly hairs, top of head bidentate; eyes reddish; ocelli not visible; antennæ scarcely visible; clypeus set off by distinct white suture. Thorax brown with broad, white, median dorsal band; segments distinct and subequal; each segment with a stiff, white bristly hair on each side dorsal line and two lateral bristles on each side, one below the other. Abdomen brown on lateral areas, white on dorsal line, under surface white; eight distinct segments each armed with a pair of long bristles above and two single bristles on each side; first abdominal segment short, eighth long, others equal in length; anal tube long, dark colored, evaginated; tip of abdomen

distinctly upraised. Legs uniform gray, very hairy; tarsi ferruginous. From a nymph killed and described immediately on its emergence from the egg.

During this instar the nymph increases in length about .6 mm., and gradually becomes darker in color.

#### *Second Instar.*

Measurements: Length 2–2.5 mm.; maximum width .5–.8 mm.

Dark brown, lighter on dorsum, top of head white; median dorsal line distinct, a row of bristles down each side of median dorsal line; abdomen broad, tip upraised; sides of thorax and abdomen hairy, hairs not in rows.

Head broad, dark brown except dorsal apex which is white; produced above, dorsal apex in two tubercles; very faintly pubescent; eyes reddish, borders white; ocelli small, white; antennæ very small; clypeus long, distinct; beak extending to a point half way between hind coxæ and tip of abdomen, mandibular and maxillary setæ capable of extension as far as tip of abdomen. Thorax brown, lighter above; each segment with one pair of strong dorsal bristles and many lateral hairs; prothorax longer than meso or metathorax and provided with a pair of strong hairs anterior to bristles; meso- and metathorax subequal. Abdomen reddish-brown, dorsal region lighter, underside red, last segment and anal tube very dark brown; each segment with a pair of dorsal bristles and many short, stiff, lateral hairs irregularly arranged; last segment twice as long as the one before it and bearing two pair of dorsal bristles. Legs mottled brown above, almost white below, not hairy; tibiæ with brown patches above; tarsi yellow-white; claws ferruginous.

#### *Third Instar.*

Measurements: Length 2.5–3.5 mm.; maximum width 1–1.3 mm.

Red-brown; frontal tubercles of head very small; pronotum prolonged posteriorly into a point partly covering mesonotum; rudimentary wing-pads distinguishable; head and thorax densely pilose, abdomen sparsely pilose; no dorsal spines on thorax, those on abdomen short.

Head broad, slightly produced forward, hairy; frontal tubercles almost obsolete; eyes prominent, red-brown; ocelli white, not prominent; clypeus long and triangular, faintly punctate and sparingly pubescent, suture at base very distinct; antennæ prominent. Thorax broader than abdomen, brown with scattered white punctures densely pilose; pronotum well developed posteriorly, covering one-half of mesonotum; meso and metathorax subequal, lateral margins produced to form first evidences of wing-pads; no median dorsal bristles on thorax. Abdomen with eight distinct segments besides anal tube; each segment except the last bearing a pair of short heavy dorsal spines, each spine ending in a fine, hair-like bristle; last abdominal segment darker in color and densely pilose; anal tube thick, heavy, often greatly distended; under side of abdomen reddish-white. Legs very light mottled brown, white below; tibiæ and tarsi somewhat hairy; claws strong, ferruginous.

#### *Fourth Instar.*

Measurements: Length 3–4.5 mm.; maximum width 1.2–1.6 mm.

Light ferruginous brown; head large; pronotum entirely covering mesonotum; wing-pads of first and second pairs of wings reaching equidistant posteriorly and covering half of first abdominal segment at lateral margin.

Head prone; frontal tuberosities scarcely visible; densely pubescent; eyes prominent, reddish-brown; ocelli small, white; antennæ prominent, short and heavy, ending in a fine bristle; beak reaching to third abdominal segment. Thorax brown, pubescent; pronotum greatly developed, covering mesonotum above; wing-pads of both segments well developed, their tips extending equally far posteriorly. Abdomen light brown, posterior margins of segments darker; sparingly pubescent; each segment except the last armed with a pair of three branched spines above and a transverse irregular growth of hairs around middle. Undersurface of body pinkish-white with patches of brown at lateral margins of abdominal segments below. Legs light mottled brown externally, white below; femora, tibiæ and tarsi hairy; claws strong and ferruginous.

*Fifth Instar.*

Measurements: Length 4.5-5.5 mm.; maximum width 1.8-2.2 mm.

Large, robust, light ferruginous marked with gray, pronotum covering both meso and metanotum above; abdomen with six pairs of heavy branched spines extending down dorsal line; entire body finely pubescent.

† Head twice as broad as long, head with eyes wider than the thorax behind it; clypeus slightly protruding forward; beak reaching hind coxæ; antennæ prominent, three jointed; eyes large, red with white borders, curved round the anterior shoulders of the prothorax; ocelli small, white; dark spot on front above each ocellus. Prothorax well developed, light brown with gray patches, hairy. Pronotum greatly extended posteriorly, covering dorsal surfaces of both mesothorax and metathorax. Wing-pads fully developed, extending to third abdominal segment. Abdomen light ferruginous brown with darker fascia around the middle of each segment; armed with six pairs of heavy, many-branched spines above; last abdominal segment robust and densely pubescent; anal tube straight and black with fringe of fine hairs at tip; underside of abdomen white with reddish lines margining the segments. Legs light mottled brown, hairy; claws heavy, fuscous.

*Adult Female.*

Measurements: Length, including tegmina, 5.7 mm.; width between humeral angles 2.6 mm.

Light chocolate brown with deep brown and yellow-white markings; pubescent; punctate; without pronotal horn; dorsum regularly rounded, sharp at posterior apex; tegmina hyaline, cloudy at base and near middle, extending beyond the posterior process, costal area punctate, terminal cell with straight transverse base; legs and undersurface of body uniform luteus.

Head wider than long, yellow brown, slightly punctate and sparingly pubescent; eyes prominent, dark brown; ocelli pearly white, equidistant from each other and from the eyes and situated on a line drawn through center of eyes; antennæ short, three-jointed, the last segment fine and hairlike; clypeus extending slightly below marginal line of loræ when viewed from the front, sparingly pilose; beak reaching hind coxæ. Pronotum finely punctate, pubescent, gradually rounded above the head; humeral angles rounded, not prominent, extending beyond the eyes to a distance equal to the width of the latter; faint percurrent, median carina; posterior process strong, acute, sharp at tip, extending as far as the terminal cell of the tegmina. Color of pronotum yellowish-brown with markings of dark brown and white. Irreg-

ular brown spots on front of pronotum over the eyes; diagonal light band extending on each side from apex of metopidium to lateral margin, this band having a dark brown posterior border; broad transverse light band just before posterior apex, this band bordered before and behind with dark brown. Tegmina subhyaline, extending beyond the apex of the posterior process of the pronotum; basal area fuscous and punctate; costal cell punctate for almost its entire length; fuscous cloud in middle of tegmina continuing the dark pattern of the pronotum above. Underside of abdomen orange yellow; sheath of ovipositor yellow. Pectoral regions and legs uniform yellow. Femora pubescent; tibiae pubescent and armed with very small, black-tipped spines; tarsi fuscous; claws ferruginous.

*Adult Male.*

Measurements: Length 4.6 mm.; width 2.3 mm.

Smaller and darker than the female and having the dorsal line slightly depressed just behind middle as seen from the lateral aspect. Color deep brown, almost black; fascia narrow but conspicuous on account of the dark color around them. Tegmina with veins very heavy and black. Undersurface of abdomen dark brown, segments margined with white. Legs uniform dark brown; femora smooth; tibiae with yellowish pubescence; tarsi and claws fuscous.

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## EXPLANATION OF PLATE.

Fig. 1. Egg.

1. 2. Egg-mass.
3. Longitudinal section of stem showing position of egg at base of old bud scale.
4. First instar.
5. Second instar.
6. Third instar.
7. Fourth instar.
8. Fifth instar.
9. Adult female.
10. Adult male.

## NOTE ON THE SPECIES OF THE GENUS ACROCERA.

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Most of the species of this genus have remained practically unknown since they were described. This is undoubtedly due to poor description on the one hand and to the scarcity of material on the other. Since obtaining my first specimen in 1895, only seventeen additional specimens have come under my observation, representing perhaps seven species. The variable and vestigial character of the venation offers an attractive field for study if only sufficient material could be obtained. The species, so far as known, parasitize the ground spiders of the genera *Lycosa* and *Amaurobius*, and no doubt a number could be obtained by raising the various species of spiders of these genera. The late Dr. T. H. Montgomery in conducting some studies on the Lycosids, bred a number of *Acrocera fasciata*, and I remember he said that he could detect those which were parasitized, long before there was any other indication, by their weaker and more poorly constructed webs, the parasite evidently affecting the functions of the spinneret.

The brief Latin descriptions by Westwood (Trans. Ent. Soc., London, V, 91, 1848), are very trying, and the positive identification of some of his species seems almost impossible with so little material, especially from the southern states—three of his species being described from Georgia. I can therefore present only the following provisional table and notes, trusting that they may lead to a further study of this interesting genus: